Use Reanalysis to Give Better Data for the Arctic

- We need to make the best use of the observations we have.
- We need some additional model development.
- We need Arctic region activities that can help two projects:
  - Future global reanalysis projects
  - And a possible Arctic regional reanalysis (using boundary conditions from a global reanalysis)

Roy Jenne
Dec 2001

- Slides for the reanalysis panel on Nov 29, 2001 at the Arctic meeting in Seattle.

We Need Data for the Whole Arctic

1. Get wide area data in space and time
   - From reanalysis
   - From satellites

   (We will not have many local surface observations for central Arctic, but we will have some.)

2. Also need local data
   - To measure many other variables
   - For part of Arctic's observing net
   - To understand various processes
     - And these help algorithms in models
   - For time series trends at stations

Roy Jenne
29 Nov 2001

Make Better Analysis, Arctic Upper Air
(Get Temp, Wind, Pressure, ?)

1. Do work to help next global reanalysis
   - Evaluate model output
   - Help improve algorithms
   - Prepare more observations

2. Help achieve models with low temperature bias
   - Then only a small bias in areas of thin observations.

3. Evaluate forecast scores on local basis.
   - Not just hemispheric or North America
   - Did model get enough observations? Scores help tell.

4. Do analysis expts using 4D-Var

5. Do a regional Arctic analysis?
   - The computer power is here.
   - Keep this option open!

6. The observations and analyses for 1880 – 1947

People often want to know about Arctic trends. To help describe Arctic trends, a very long record of observations and paleo data is very helpful, even if it is less than perfect.

- Summarize information for observations and analyses.
- What is the state of archived paper data?
- List options to prepare more data.
- Consider methods to analyze older years.

Roy Jenne

29 Nov 2001

Hand Analysis Continuity and 4D-Var (Atmospheric Analysis Methods)

1) 4D-Var has been used for production at ECMWF starting 1997.
   - It added almost one day to the time period for good forecasts.
   - Since it is used for production, it can't look at observations ahead of the present time.
   - It looks at observations during a 12-hour period (to minus 12 hours).
   - At a given resolution, the computer time needed for 4D-Var is about 3 times that needed for 3D-Var (with a 12-hour window for observations). A time factor this small is an achievement.

2) Time continuity was used in the best old hand analyses of the atmosphere.
   - People often kept an analysis map "open: for a day or two after map time so that they could get the benefit of future observations, and so that sensible time continuity could be achieved.

3) We conclude that:
   - It helps to make use of future data.
   - A time window of observations for 4D-Var of only 12 hours seems small.

Roy Jenne
Dec 3, 2001

Analysis Methods

Method		Brief Description of Method
Cressman	1960-on	▪ Weight an obs by distance ▪ Do large scales first
O/I	ERA-15 EC 1980-95	Better way to weigh the obs
3D-Var	NCEP/NCAR NCEP-2 ERA-40 EC Opns 1996-on	Fit the obs at one time and also demand dynamic consistency of the 3D analysis

4D-Var EC 1997-on

- Fit all the obs over a time period
  - Over 12 or 24 hrs
  - ECMWF now uses 12-hr period
- Get dynamical consistency in time and space
- Like the old hand analysis that looked back & forth in time
- 4D-Var makes better use of sparse obs
  - And use the obs at its real time
  - But it demands tighter QC of data

Example: A surprise storm hits an island. It existed earlier.

Use of 3D-Var at NCEP:

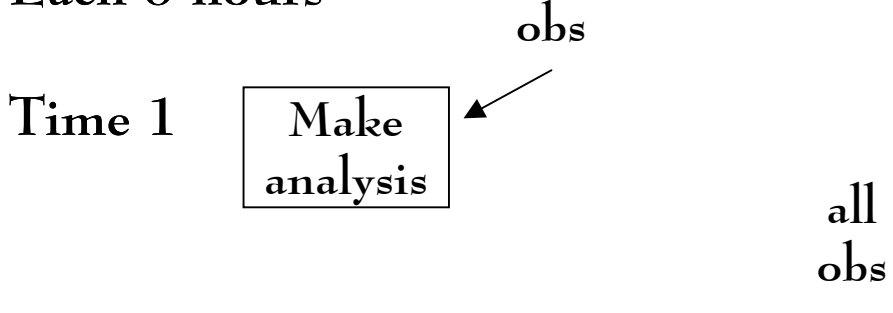
- Started 1995 in NCEP production
- Used for NCEP/NCAR reanalysis (1948 – on)

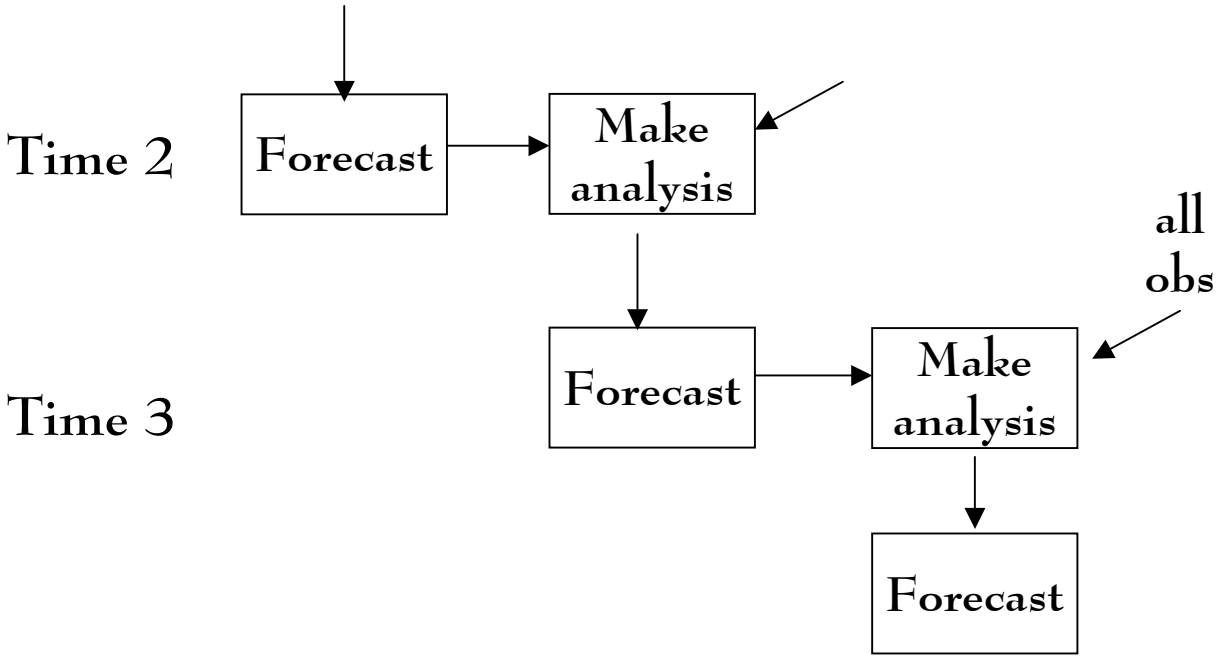
Roy Jenne
Nov 2001

Analysis Continuity in Time

1. Cressman, O/I, 3D-Var methods go forward in time

   - Each 6-hours





2. The 4D-Var method goes back and forth in time

- The present operational methods at ECMWF ingest 12 hours of observations at one time. They develop an analysis at different time points in the 12-hour period that fit the observations, and have dynamical consistency in time and space.

Roy
Jenne

Help Analyses in Arctic; Older Years

1. **Add some more observations**
   - More Canadian raobs before 07/1955

- Early Canada surface pressure and temperature observations
  Now weak for 1948 – 1966
- Get T3 raobs
- Russian North Pole raobs
  Better data now available (11/2001)

2. **Use VTPR and TOVS in best ways (11/1972 – on)**
   - The world is getting closer to doing this .

3. **Improve analysis methods**

4. **Question: Are the observations always better in later years?**
   - No.
   - Have more permanent ship raobs for 1948 – 73.
   - Have polar recon flights for early years.
     And have ocean recon flights.
   - Russian North Pole raobs 1954 – 91.

Roy Jenne
29 Nov 2001

How to Help Observations for Arctic Future

GOAL: DESCRIBE WIND, TEMPERATURE, PRESSURE, EACH 6-HOURS OVER ARCTIC FOR MANY YEARS

- Are there enough observations in Arctic?
  - Compare 2 reanalyses with each other
  - Also use forecast scores
- Better satellite sounders
  - These are coming (AIRS comes about 6/02)
- Want a satellite LIDAR wind satellite
  - Talk since ~1984 (no results yet)
  - New options are better and cheaper

- I hear there is a push for these winds

- Surface ice buoys with SLP
  - These help a lot!

Roy Jenne

Nov 28, 2001